

# Night Vision Goggle Plate “Machine vs. Cast” Study

Project Number #NP06012111

Final Report  
22 December 2006

Letterkenny Army Depot  
Chambersburg, PA

Submitted by



National Center for Defense Manufacturing & Machining  
Lee McCullough, Project Lead  
1600 Technology Way  
Latrobe, PA 15650  
(724) 539-5901 Phone  
(724) 539-5132 fax  
[www.ncdmm.org](http://www.ncdmm.org)

Report Documentation Page			Form Approved OMB No. 0704-0188		
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE <b>22 DEC 2006</b>		2. REPORT TYPE <b>Final</b>		3. DATES COVERED <b>23-11-2006 to 28-03-2007</b>	
4. TITLE AND SUBTITLE <b>Night Vision Goggle Plate ?Machine vs. Cast? Study</b>			5a. CONTRACT NUMBER		
			5b. GRANT NUMBER		
			5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S) <b>Lee McCullough</b>			5d. PROJECT NUMBER <b>06-0121-11</b>		
			5e. TASK NUMBER		
			5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>National Center for Defense Manufacturing &amp; Machining,1600 Technology Way,Latrobe,PA,15650</b>			8. PERFORMING ORGANIZATION REPORT NUMBER		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSOR/MONITOR'S ACRONYM(S)		
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)		
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT <b>The National Center for Defense Manufacturing and Machining (NCDMM) was requested to assist Letterkenny Army Depot (LEAD) in performing a ?Machine vs. Cast? study for the A3297308-1 plate (bracket), part of the A3297308 Front Bracket Assembly, figure 1, used on the ACH/CVC helmet Night Vision Goggle (NVG) kit, A3297037. LEAD has the capability to manufacture the plate using their existing equipment; however, there are several options that should be evaluated when selecting the best overall path considering part cost, capital requirements, shop capacity and volume of future orders.</b>					
15. SUBJECT TERMS <b>National Center for Defense Manufacturing and Machining; NCDMM; Letterkenny Army Depot; Night Vision Goggle</b>					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>Same as Report (SAR)</b>	18. NUMBER OF PAGES <b>11</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			

# **Letterkenny Army Depot Engineering Support**

## **Night Vision Goggle Plate “Machine vs. Cast” Study**

### **1.0 EXECUTIVE SUMMARY**

The National Center for Defense Manufacturing and Machining (NCDMM) was requested to assist Letterkenny Army Depot (LEAD) in performing a “Machine vs. Cast” study for the A3297308-1 plate (bracket), part of the A3297308 Front Bracket Assembly, figure 1, used on the ACH/CVC helmet Night Vision Goggle (NVG) kit, A3297037.

LEAD has the capability to machine this part using their existing Haas VF-5 machining centers equipped with new in-house built fixturing. This approach has a reasonable cost target of approximately \$12.83 per part. The cost to purchase a finished machined part from an outside vendor is approximately \$13.33.



**Figure 1. NVG Front Bracket Assembly**

However, there is an attractive alternate manufacturing method of aluminum die-casting which yields completed parts for approximately \$4.06 each, including amortization of tooling. The parts currently in the government supply system have been produced by this aluminum die casting method. Once the tooling has been amortized the part cost drops to approximately \$2.83 each.

One scenario evaluated in this report, that of purchasing un-finished die cast parts as components and then finishing with a few operations in-house, has significant merit. When combined with the automatic forming machine approach for the clip (covered in a separate report, submitted 18 December 2006), LEAD could perform all “manufacturing operations” in-house on both parts and likely become the low cost supplier among other government sources.

When using the machine in-house for the complete plate and hand form the clip approach, the combined estimated cost for both parts is \$14.27 vs \$5.92 (including tooling) for the cast part and automatic forming scenarios.

Using this approach, LEAD may be able to increase it's margin and share a portion of the savings with it's customer.

Because of these significant cost differences, areas requiring additional review include: financial and operational aspects of outsourcing, cost & pricing, LEAD shop capacity implications, potential overhead absorption and future order volume.

## 2.0 **INTRODUCTION**

2.1 The National Center for Defense Manufacturing and Machining (NCDMM) was requested to assist Letterkenny Army Depot (LEAD) in performing a "Machine vs. Cast" study for the A3297308-1 plate (bracket), part of the A3297308 Front Bracket Assembly, figure 1, used on the ACH/CVC helmet Night Vision Goggle (NVG) kit, A3297037.

LEAD has the capability to manufacture the plate using their existing equipment; however, there are several options that should be evaluated when selecting the best overall path considering part cost, capital requirements, shop capacity and volume of future orders.

2.2 Two basic methods of manufacture are available for the plate. Because of the short lead-time and high volume (52,000 pieces), four different scenarios were investigated:

- **Machine parts in-house using existing equipment.**
- **Purchase finished machined parts from an outside vendor.**
- **Purchase finished die cast parts from an outside vendor.**
- **Purchase un-finished die cast parts from an outside vendor and complete in-house.**

2.3 The major areas of concern in the comparison analysis were:

- Overall cost.
- Effect on LEAD's capacity, while maintaining day-to-day operations.
- Generating direct labor hours for overhead absorption.

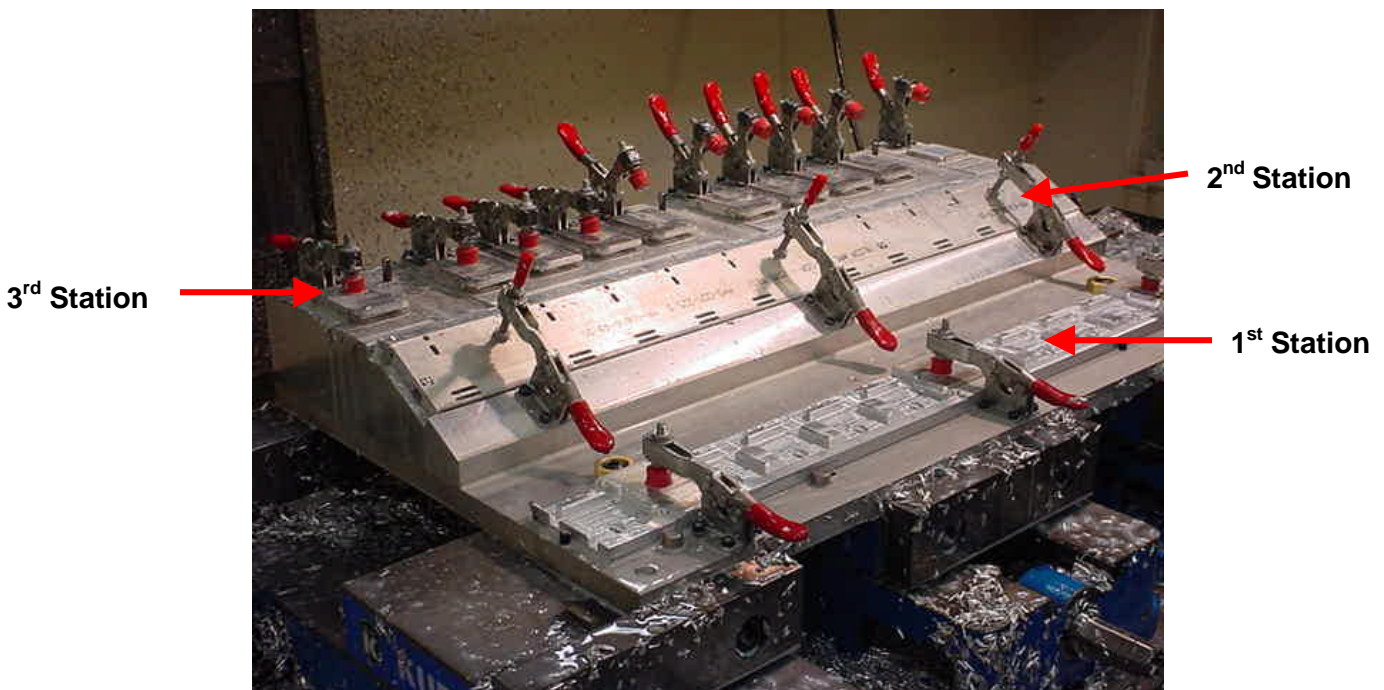
- Impact of amortized capital cost on piece part cost on existing and future orders.
- Possible limitations on outsourcing, the cost basis and pricing strategy.

### 3.0 **ANALYSIS**

Attachment “A” contains the estimated cost details for each scenario in the cost analysis.

#### 3.1 **Machine all parts in-house using existing equipment.**

This is the approach currently being followed by LEAD. Fixturing from Tobyhanna Army Depot, which is currently manufacturing the same part, has been duplicated with necessary modifications for LEAD equipment. The Tobyhanna fixturing approach is a good method for the complexity of this part. Figure 2 shows the plate machining fixture loaded with 30 parts in the 3 stages of the machining process.



**Figure 2. Plate Machining Fixture**

The machining cycle consists of a continuous flow with three set-ups, each set-up moving 10 parts from station-to-station. A set-up consists of the following steps:

1. 10 completed parts are removed from the top clamps (3<sup>rd</sup> station where the individual parts are cut from the bar).
2. A semi-finished bar is then moved from the 2<sup>nd</sup> station (middle position on slanted surface) to the 3<sup>rd</sup> station.
3. The bar with front detail machined is then moved from the 1<sup>st</sup> station to the 2<sup>nd</sup> station.
4. A blank bar for 10 more parts is loaded in the 1<sup>st</sup> station.

If required, the parts will then be tumbled to remove burrs and sent out for anodizing.

Blank bars for 10 parts are cut from 12' stock on a cutoff saw in a separate operation prior to machining.

The machine cycle time for 10 parts is targeted by LEAD to be 60 minutes. This will enable a single machining center to produce approximately 70 parts per shift. Therefore, based on an average 21 workday month, 4.8 machine-shifts of operation are required each day.

The total cost per part for this process is estimated at \$12.83 including outsourcing the anodizing. As this is based on machine run-time at the standard rate of \$93.49 per hour, this calculated cost is independent of volume and capacity considerations.

Currently three sets of fixtures are being prepared so that the monthly volume can be produced by a variety of shop loading schedules including running 3 machines simultaneously.

The cost impact of a single operator running multiple machines has not been considered in this analysis.

### **3.2 Purchase finished machined parts from an outside vendor.**

This same completely finished machined and anodized part may be purchased on the outside for prices ranging from approximately \$14.85 for 1000 per month to \$13.33 for 7000 per month.

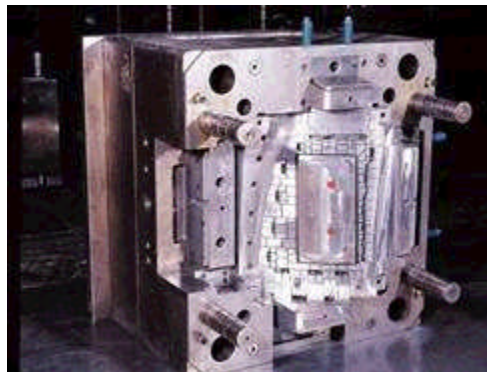
Depending on the vendor selected, it is possible to begin production in 2 weeks, ramping up to producing 7000 parts per month within an additional 4 weeks.

### 3.3 **Purchase finished die cast parts from an outside vendor.**

The current parts in the government supply system are manufactured by the aluminum die casting method. This technique uses a mold to shape molten aluminum to a configuration very close to the finished part. A simple operation to trim molding “flash” and “runners” from the parting line of the mold and injection points is required to bring the part to point where only a short machining operation is necessary to insert the 4 tapped holes and cleanup several close tolerance areas.

The part is then at the equivalent point in the manufacturing process as those removed from the Haas VF-5 machining center; but, at a cost of approximately \$2.05, less than 20% of the machined cost (less than 30% with tooling cost amortized).

Figure 2 shows a typical mold removed from the automatic die casting machine.



**Figure 2. Typical die cast mold.**

The following are the main factors yielding the low cost in this manufacturing method:

- The aluminum is purchased in bulk, at a low “raw material” price without the need for secondary mill operations such as rolling or forming by the casting manufacturer.
- There is virtually no scrap, waste or “cutting chips” because only the material need for the actual part is used. (Trim is re-melted and used over.)
- A multi-cavity mold is typically used with an automatic injection and trimming process, producing at least 6 parts at one “shot” with minimal labor content.
- The remaining machining operations are simple and can be easily performed on basic machine tools.

This analysis includes the cost of a 6-cavity mold and trim die costing approximately \$49,000. These tools have an estimated life of 125,000 to 150,000 “shots” producing 750,000 to 900,000 parts with normal tool maintenance costing approximately \$1500 every 25,000 shots.

The completely finished and anodized cost per part is estimated at \$4.06 including tooling amortized over the first 40,000 parts and drops to \$2.83 for future orders using the same tooling.

Because the cost is extremely material sensitive, vendors usually quote prices based on the current material cost. If there are raw material price changes, they are passed thru at the vendor cost in effect at the time of production. This estimate is based upon aluminum alloy 380 at \$1.15 per pound.

Pre-production sample parts will be available for approval 8 weeks from final design review. Production parts will be available 4 weeks from pre-production approval.

#### 3.4 **Purchase un-finished die cast parts from an outside vendor and complete in-house.**

Another scenario is to purchase “trimmed” die cast parts as a raw material component and bring in-house to perform the machining and deburring operations. The parts would then be sent out for anodizing as in the machining in-house scenario.

This approach will increase the cost slightly from approximately \$4.06 to \$4.33.

The lead-time for this approach is essentially the same as for finished cast parts.

### 4.0 **KEY DATA SUMMARY**

Table 1 summarizes the costs per part anticipated with each scenario on this current order and anticipated costs on follow-up orders of similar size.

**Table 1. Piece Part Price Comparison**

Scenario	Initial 52,000 parts (Includes equip & tooling) Cost \$ Each	Follow-on Orders  Cost \$ Each
LEAD make, machined	12.83	12.68
Buy, machined	13.33	13.33
Buy cast, finished	4.06	2.83
Buy cast, LEAD complete	4.33	3.10



Table 2 summarizes the man-hours generated and equipment utilization for each scenario.

**Table 2. Capacity Impact (Current 52,000 piece Order)**

Scenario	Man-hours per month	Equipment utilization (shifts per month)
LEAD make, machined	731	104
Buy, machined	0	0
Buy cast, finished	0	0
Buy cast, LEAD complete	117	17

## 5.0 **CONCLUSIONS**

### 5.1 **General**

Because of the significant difference in cost between cast and machined parts, the impact of each scenario must be considered in detail. This report will present as many facts as are currently available to aid in the decision process.

Regardless of which scenario is ultimately selected, LEAD must manufacture parts for at least an interim period to meet the production schedule. In order to meet the cost estimates and reduce machine time to the targets identified in this report, the process must be optimized to reach a maximum cycle time of 60 minutes per 10 parts

### 5.2 **Machine all parts in-house using existing equipment.**

This approach generates the most direct labor hours, 700 per month; but also uses significant capacity of 4.8 machine shifts per day. The current 2-shift operation has only 6 machine-shifts available per day. Adding a 3<sup>rd</sup> shift with all three available machines running would still require one machine to run for 2 additional shifts to achieve full production. This would commit 1/3 of the existing capacity plus a full 3<sup>rd</sup> shift to this project.

Assuming the cost target of \$12.83 is met, this approach has the lowest cost of the machined part scenarios.

### 5.3 **Purchase finished machined parts from an outside vendor.**

This same finished machined part may be purchased on the outside for prices ranging from approximately \$14.85 for 1000 per month to \$13.33 for 7000 per month. This approach is less desirable, as this scenario has a premium over in-house manufacturing and generates no direct labor.

However, a version of this scenario may be used during periods of peak loading in the LEAD shop, during ramping up of a 3<sup>rd</sup> shift capability or as other business constraints dictate.

By developing a qualified outside source, LEAD can balance capacity constraints thru selective outsourcing. It may be beneficial to give the outside shop a base load and make provisions for additional quantities as the need arises.

There is a part cost premium over in-house costs, but the benefit from the large volume of overhead absorption from the in-house portion of this project can be considered in the total cost to implement this approach.

#### **5.4 Purchase finished die cast parts from an outside vendor.**

Purchasing die cast parts produces the lowest overall project cost, as shown in table 3, but does not generate any direct labor nor absorb overhead. It is being considered because the current parts in the Army system are manufactured by this method and it is the typical method to produce parts in high volume.

In the long run, it may be necessary for LEAD to implement this scenario if it wishes to be the low cost supplier and thus potentially obtain all the available volume for the complete NVG bracket kit.

Because the part was quoted to LEAD's customer using a machined cost structure, there may be outsourcing limitations in the contract and/or LEAD's operation policies. In addition the need for a capital investment of \$49,000 (which can easily be amortized over the first order and still produce significant savings) and other factors of this scenario should be evaluated further within the Depot business model to arrive at the proper decision.

#### **5.5 Purchase un-finished die cast parts from an outside vendor and complete in-house.**

By purchasing the "trimmed" die cast part and performing all the machining it in-house, it is possible to take advantage of the low cost die casting process while not out-sourcing services. This approach may be implemented by treating the die cast part as a purchased item equivalent to raw material rather than an out-sourced fabrication.

The machining and tumbling operations would then be performed in-house before sending out for anodizing.

This approach generates 117 man-hours of direct labor per month, only requires 1 shift per day of machine center capacity and still has a low cost of \$4.33 per part.

## 5.6 Timing.

Because of the requirement to begin shipments in December 2006, it is necessary to begin manufacture in-house immediately using the machine all parts in-house using existing equipment scenario.

In addition, if this scenario is chosen, LEAD must manufacture parts thru March 2007 as a minimum, as the lead-time to purchase cast parts is at least 12 weeks.

## 5.7 Total Costs.

Table 3 summarizes the total costs, including amortization of tooling, of each of the main scenarios.

The areas highlighted in yellow are for parts manufactured at LEAD.

The costs for a future order of the same size are shown in the last 2 columns.

**Table 3. Total Costs**

Delivery Schedule and Costs														
Month	Cost	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Future	Future
Qty	Each \$	500	2500	5000	7000	7000	7000	7000	7000	7000	2000	52000	Cost	Cost (52.5K)
LEAD make														
Cost \$	12.83	6415	32075	64150	89810	89810	89810	89810	89810	89810	25660	667160	Each	Total
													12.68	659360
Purchase Finished Machined														
Cost \$	13.33	6415	32075	66650	93310	93310	93310	93310	93310	93310	26660	691660	13.33	693160
Purchase Cast Finished														
Cost \$ (inc tool)	4.06	6415	32075	64150	89810	28420	28420	28420	28420	28420	8120	342670	2.83	147160
Purchase Cast LEAD Complete	4.33	6415	32075	64150	89810	30310	30310	30310	30310	30310	8660	352660	3.10	161200
Cost \$ (inc tool)														

## Attachment "A" Estimated Cost Detail

Machine vs Cast analysis						
NVG Plate A3297308-1						
<b>LEAD Manufacture</b>						
			LEAD labor rates			
Tooling (3 fixtures)	7500			\$/hr	\$/min	\$/sec
			Machining	93.49	1.56	0.026
Cycle time/part, bar blanking (sec)	16.0					
Cycle time/part on Haas (min)	6.0					
Parts/hour (Haas)	10.0					
Parts/ shift/machine	70.0					
7000 parts per month						
# shifts per day	4.8					
Shifts/ 1000 parts	14.3					
Piece part cost			Material 1/2 x3 bar (\$/ft)	9.490		
Blanking	0.42		Material each part	2.278		
Machining	9.35					
Material	2.28					
Debur	0.03					
Sub total (In house)	12.07		Monthly man-hours and equipment utilization			
				(7000 parts per month)		
Coating	0.55		Machine	Man-hours	Equipment utilization (shifts)	
Shipping 2x	0.06		Blanking	31	4	
Sub total (Out source)	0.61		Machining	700	100	
Total	12.68					
Tooling amortization (52K units)	0.15					
Grand total 1st contract ea	12.83					
<b>Purchase Finished Part (Machined)</b>						
Piece part cost (7000/mo)	13.30					
Shipping	0.03					
Total	13.33					
<b>Purchase Cast Part</b>						
	Finished	LEAD complete				
Tooling	49000	49000				
			Monthly man-hours and equipment utilization			
Cost each (trim & pack)	0.88	0.88		(7000 parts per month)		
Debur	0.17	0.03		Man-hours	Equipment utilization (shifts)	
Machine	1.00	1.55	Machining	117	17	
Coating	0.75	0.55				
Shipping	0.03	0.09				
Sub-total	2.83	3.10				
Tooling amortization (40K units)	1.23	1.23				
Grand total 1st contract ea	4.06	4.33				